Middle Devonian (Givetian) Silica Formation of Northwest Ohio - Description and Road Log[1]

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ABSTRACT. **Middle Devonian marine strata are examined in this field trip to the former Medusa South-South Quarry (now the property of the France Stone Company) at the famous Silica locality of Lucas County in northwest Ohio. The formations exposed are the Dundee Limestone, Silica Formation, and Ten Mile Creek Dolomite. Lithologies and profuse fossil content of the Silica Formation suggest an open marine depositional setting contiguous with seas in Ontario and New York. Biostratigraphy indicates correlation of the Silica Formation with part of the Hamilton Group of New York, Pennsylvania, and West Virginia; with the Plum Brook Shale of north-central Ohio; with the Bell Shale of Michigan; and, with the Hungry Hollow Formation of southwestern Ontario.**

OHIO J. SCI. 91 (1): 27–34, 1991

INTRODUCTION

This field trip provides an opportunity to examine one of the best known and most profusely fossiliferous of Middle Devonian exposures. Tens of thousands of people have collected fossils from the Silica Formation since quarrying began at Silica, OH, in the 1920s (Kesling and Chilman 1975). Emphasis will be on identifying the most fossiliferous stratigraphic horizons and on providing adequate time for fossil collecting. Secondary emphasis will be on primary and diagenetic lithologic features and their relations to faunal assemblages, the sequence of depositional environments recorded, and on interregional correlations.

The shale and carbonate units exposed record exclusively marine deposition on what is now the northwestern flank of the Findlay Arch. These formations are truncated by erosion southeastward and regionally dip very gently northwestward into the subsurface of the Michigan Basin. Exposures examined on this trip, however, are on the Lucas County Monocline, a local north-south trending flexure nearly restricted to Lucas County, OH, and on which dips average approximately 6° due west (Fig. 1).

This area of Lucas County has been a center of the stone industry since the turn of the century. Quarries were excavated in sandstone, limestone, and shale formations by a succession of companies including the Toledo Stone and Glass Company, Sandusky Cement Company, Medusa Portland Cement Company, and France Stone Company. Erosion of the Lucas County Monocline has exposed a succession of different Devonian lithologies in close proximity to one another (See Fig. 1). Quarrying was concentrated where the glacial overburden was thin.

Although all the quarries have features of geologic interest, the best known sites are the former quarries of the Medusa Portland Cement Company, located west of Centennial Road (Fig. 2). The Medusa South Quarry, located just north of the excavation visited on this field trip, was the original site from which the well known Silica fauna was collected. In later years, quarrying proceeded along strike, north of Brint Road, to the Medusa North and North-north quarries. The north quarries were abandoned around 1970 and excavations began on property adjacent to the France Stone West Quarry; a site called the Medusa South-South Quarry – the destination of this field trip. This quarry is now the property of the France Stone Company.

FIELD TRIP ROAD LOG

Assembly point for the trip will be in the parking lot of the Secor Inn at I-475 and Secor Road in Toledo, OH. A bus will depart from this location at 8:00 AM, Saturday, 20 April 1991, for the quarry.

Cumulative Mileage		
0.0 mi	(0.0 km)	Leave Secor Inn. Turn right on Secor Road and proceed to intersection of Monroe Street.
0.3 mi	(0.4 km)	Turn left on Monroe Street, stay in left lane.
0.6 mi	(0.9 km)	Bear left on Sylvania Avenue at traffic light.
2.6 mi	(4.2 km)	University of Toledo Stranahan Arboretum on right.
3.0 mi	(4.8 km)	Bridge over Ten Mile Creek (Ottawa River).
4.8 mi	(7.7 km)	This wide sand belt represents beach deposits of glacial lakes Warren, Wayne, and Lundy, all ancestral to present-day Lake Erie.
6.3 mi	(10.1 km)	Bridge over Ten Mile Creek. Farther upstream is the type location of the Ten Mile Creek Dolomite, a unit we will see in the Medusa South-South Quarry.
6.6 mi	(10.6 km)	To the left, behind the trees, is what remains of the abandoned quarry of the Toledo Stone & Glass Company. The Sylvania Sandstone was quarried from this site and used by the early glass factories of Toledo. The Sylvania Sandstone is the oldest Devonian strata exposed in northwestern Ohio.
6.7 mi	(10.7 km)	Bridge over quarry roadway. To the south and north are quarries

[1]Manuscript received 6 August 1990 and in revised form 5 November 1990 (#90-24).

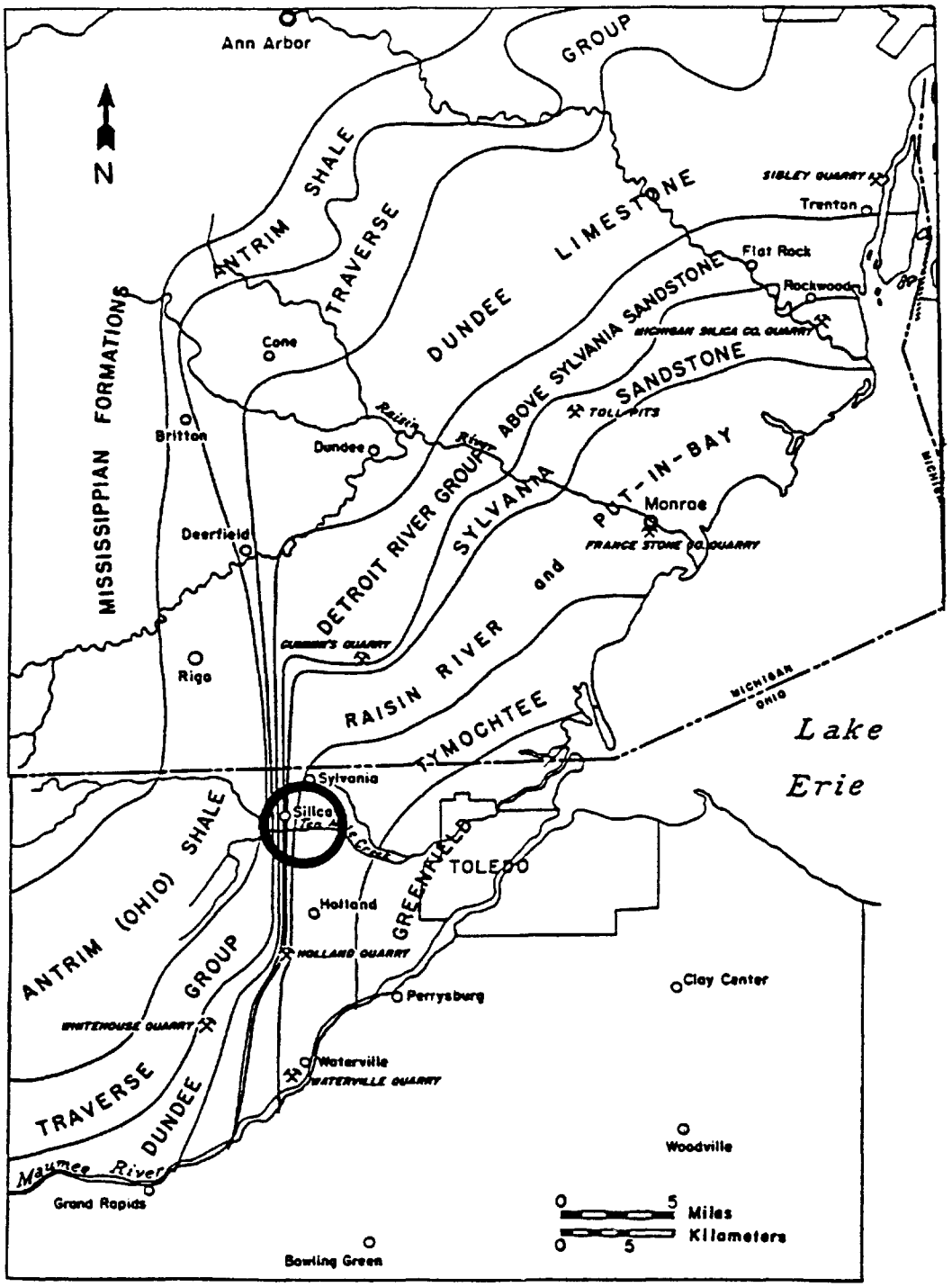

FIGURE 1. Outcrop belts of formations in field trip area. Modified from Ehlers, Stumm, and Kesling (1951).

exposing strata of the Middle Devonian Detroit River Group which overlie the Sylvania Sandstone, but are older than the strata exposed in the Medusa South-South Quarry just west of this site.

6.8 mi (10.9 km) Centennial Road intersection. To the south, down this road, are the remanents of the village of Silica.

7.1 mi (11.4) km) STOP. Medusa South-South Quarry.

STRATIGRAPHY

This quarry exposes, in stratigraphic order, the Dundee Limestone, Silica Formation, and Ten Mile Creek Dolomite. The Silica Formation, which is predominantly shale, averages about 55 ft (17 m) in thickness here and, with the overlying Ten Mile Creek Dolomite (38 ft or 11.5 m thick), represents the Middle Devonian Traverse Group in northwest Ohio.

On east-west trending quarry walls, the 6° westward dip of the Lucas County Monocline is clearly discernible. This dip results in the exposure of several Middle Devonian formations in a small area surrounding this quarry (Fig. 2).

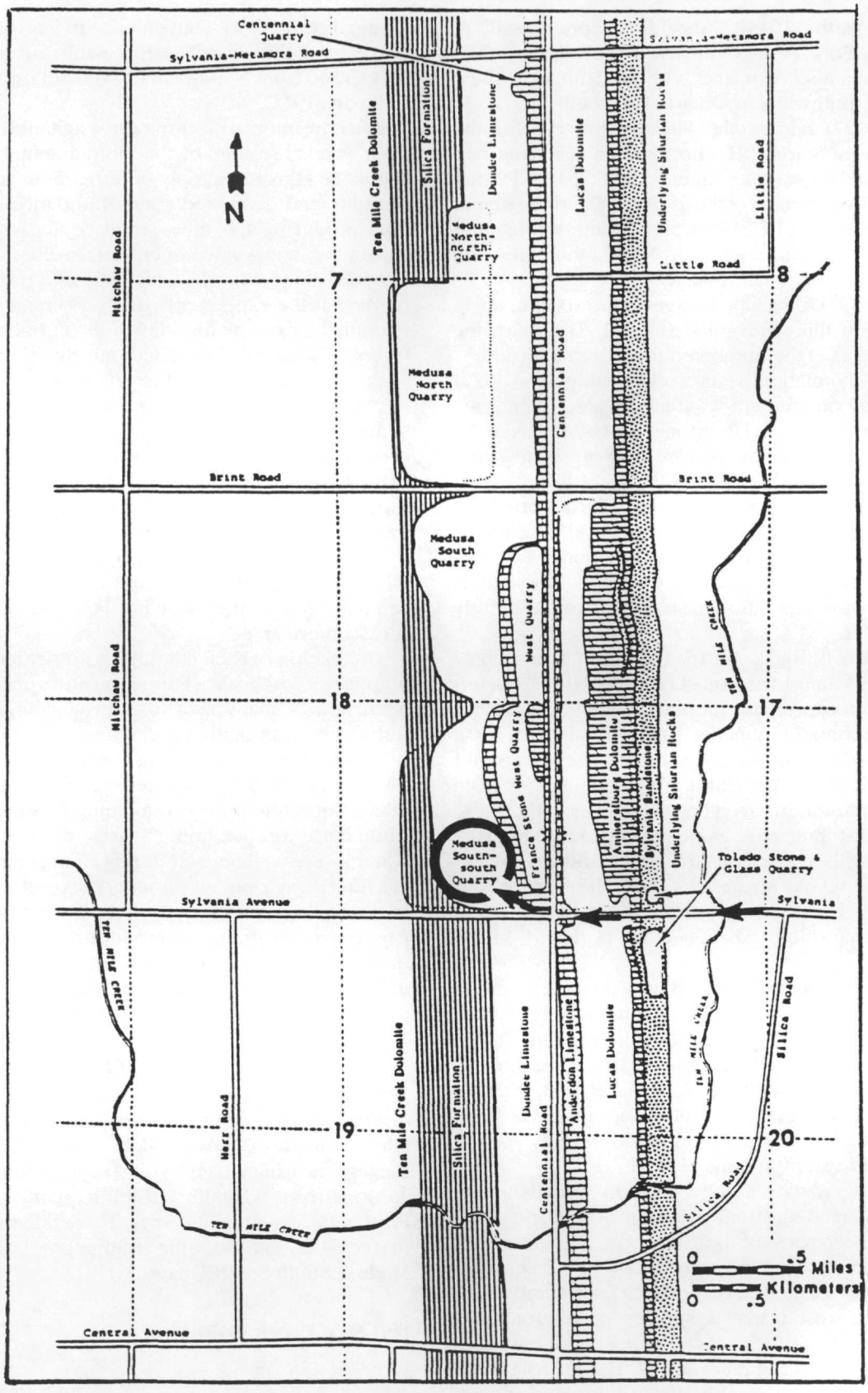

FIGURE 2. Map of quarries and exposed units near Silica, OH. Modified from Kesling and Chilman (1975).

The Dundee Formation is 61 ft (18.6 m) thick and has been correlated with the Marcellus Formation of the lower Hamilton Group of New York and Pennsylvania and with the Delaware Limestone of north-central Ohio on the opposite (southeast) side of the Findlay Arch (Sparling 1985). The overlying Silica Formation and Ten Mile Creek Dolomite are correlative with the Plum Brook Shale and Prout Limestone, respectively, of north-central Ohio (Sparling 1985); with the Bell Shale and Traverse Limestone, respectively, of the southern peninsula of Michigan

(Cooper and Warthin 1943); and, with the upper Hamilton Group of New York, Pennsylvania, and West Virginia. The Silica Formation also correlates with the Hungry Hollow Formation of southwestern Ontario (Mitchell 1967).

Stewart (1927) named the Silica Formation for the nearby village of Silica, OH, shortly after quarrying had initially exposed these rocks. Ehlers et al. (1951) redefined both basal and top contacts of the formation, and Nussmann (1961) and Huffman (1978) interpreted depositional and early diagenetic environments by Silica lithologies and their associated faunal assemblages.

Nussmann (1961) developed the generalized stratigraphic column used in this field guide (Fig. 3). The following descriptions refer to the numbered units of this section.

The Silica Formation rests conformably or with a paraconformity on medium- to thick-bedded, light gray, very fossiliferous Dundee Limestone. Brachiopods are the most common fossils in the Dundee, and *Productella* and *Cyrtina* are the most abundant of these.

The lower parts of the overlying Silica Formation (units 1, 2, 3, and 5A) are biofragmental limestones consisting primarily of brachiopod fragments and secondarily of both tabulate and rugose corals. These units apparently record deposition in shallow, clear, and fairly turbulent water.

Units 4, 5B, 6, 8, 10, 12, 14, 16, 17A, and 19 through 27 are argillaceous limestones, most of which are characterized by concavo-convex brachiopods, massive and ramose bryozoa, and crinoid fragments. Exceptionally rich fossil assemblages (the "smothered bottom" assemblages of Nussmann [1961]) are present at abrupt transitions from argillaceous limestone to overyling calcareous shale. These very densely distributed fossils are the same fauna as in the underlying argillaceous limestone but exhibit a higher percentage of whole specimens than the argillaceous limestones. Such smothered bottom assemblages are at the following transitions: 5B–6, 6–7, 10–11, 12–13, 14–15, and 26–27.

Units 7, 9, 11, 14, 17B, and 18 are calcareous shales, which are dark gray, carbon-rich, and locally pyritic. These calcareous shale units differ from one another in faunal content, and abundant *Mucrospirifer* are particularly characteristic of units 7, 8, 15, and 17B. Unit 11 contains abundant *Devonochonetes,* and unit 18 is virtually unfossiliferous. *Phacops* is common in units 7 and 9 and, to a lesser extent, in unit 11.

The Silica Formation has yielded an abundant and diverse fauna including 40 cnidarian species, 40 species of bryozoans, 63 species of brachiopods, 21 species of bivalves, 7 species of gastropods, 6 species of cephalopods, 3 species of annelids, 6 species of trilobites, 4 species of malacostracans, 2 species of blastoids, 19 species of crinoids, 4 species of stelleroids, 1 edrioasteroid species, and a number of fish species. The microfauna is also well established; however, the 112 ostracod species are by far the most prevalent taxonomic group (Kesling and Chilman 1978).

DEPOSITIONAL ENVIRONMENT

These numbered units have been combined by Nussmann (1961) into sequences represented by Roman numerals (Fig. 3) for convenience in interpreting depositional environments. The following interpretations are condensed from Nussmann (1961) and from Kesling and Chilman (1975).

After the interval of strong wave agitation and relatively clear waters recorded by the biofragmental limestones of sequence I, greater supply of terrigenous mud increased turbidity and decreased coral abundance and diversity, thus producing the more argillaceous sequence II. As supply of terrigenous mud increased, abundance of concavo-convex brachiopods and *Mucrospirifer* also increased at the expense of corals and ramose bryozoans. Eventually, extreme turbidity and soft bottom conditions (units 9 through 13) greatly diminished faunal diversity.

Sequence III repeats the succession of sequence II exclusive of the shale above the *Mucrospirifer* zone.

In sequence IV, the stratigraphic succession of argillaceous limestone interrupted by a smothered bottom assemblage and succeeded by a *Mucrospirifer* zone, is once again repeated. As in sequence II, the *Mucrospirifer* zone is transitional to a thick and relatively unfossiliferous shale.

Sequence V records a return to argillaceous limestone which includes some fish bone fragments. Contact of sequence V with the overlying Ten Mile Creek Dolomite is disconformable.

Correlation of each lithology with particular fossil taxa is apparent in the Silica Formation and apparently records restriction of many taxa to narrow ranges of turbidity, turbulence, and bottom conditions.

Pyritization of bryozoans, brachiopods, and worm tubes is particularly characteristic of units 7 through 11, which constitute a very abundantly fossiliferous interval. Abundance of benthonic fossils dictates that bottom waters were well aerated during deposition of this interval. After deposition, sulfate-reducing conditions developed in the sediment, leading to pyrite formation. Pyritization preceded sediment compaction as evidenced by undeformed, heavily pyritized specimens of *Paraspirifer* in unit 9, whereas unpyritized *Paraspirifer* specimens in this unit are flattened and deformed.

SECTION

The following is a generalized lithologic and faunal description of each of the numbered units (Fig. 3) of the Silica Formation. It was taken with modification from Kesling and Chilman (1975) and represents a composite of sections in the old South and North quarries of the Medusa Portland Cement Company. These quarries are now inaccessible, but the same stratigraphy is present in the Medusa South-South Quarry.

Ten Mile Creek Dolomite

	Thickness ft, in (cm)
Ten Mile Creek Dolomite (base of unit)	
Limestone, dolomitic, grainy to crystalline, brownish-gray to drab, somewhat laminated, in 2–4 in (5-10 cm) thick beds.	1 ft 4 in (40.6 cm)

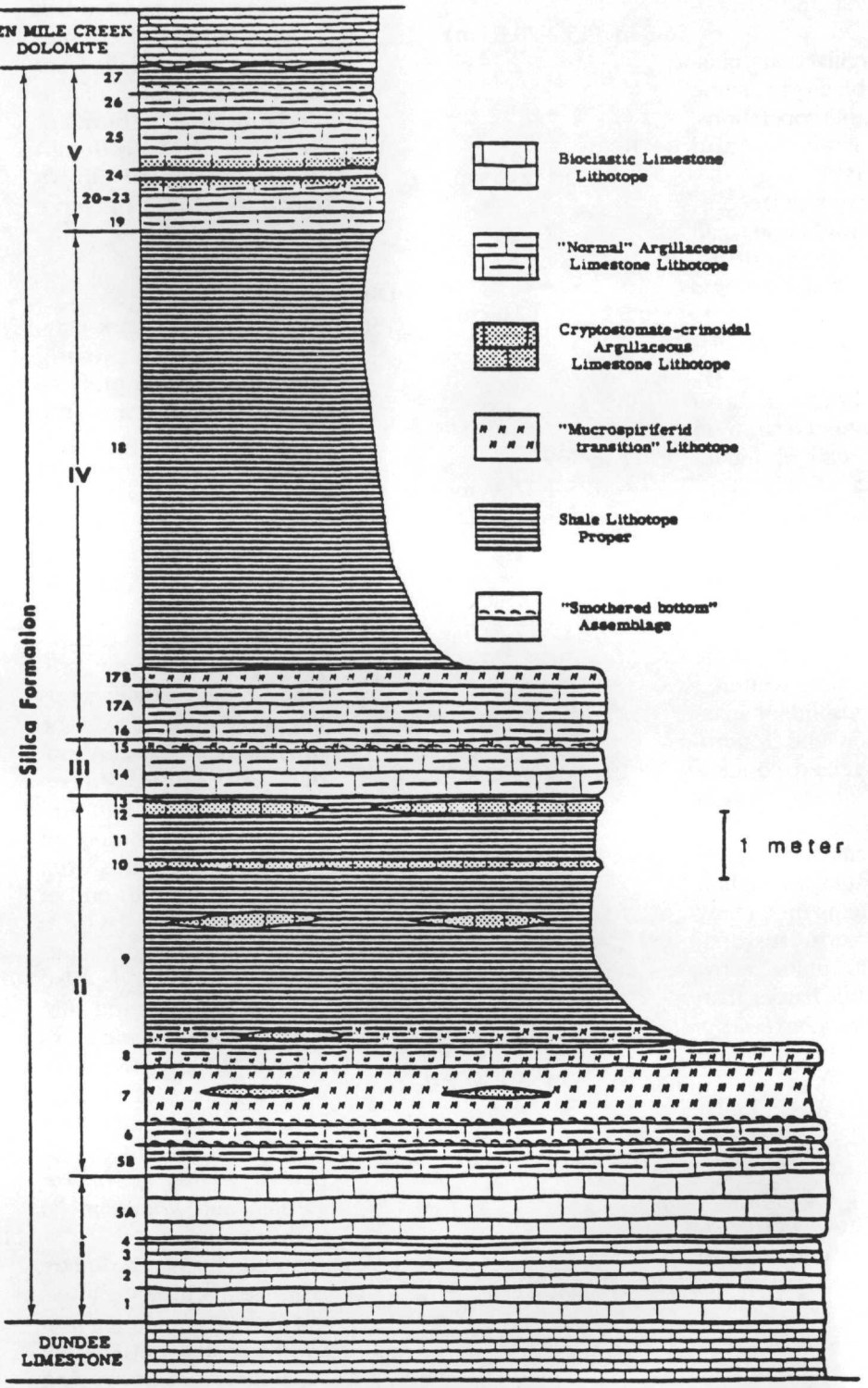

FIGURE 3. Generalized stratigraphic column for field trip area. Modified from Nussmann (1961).

Silica Formation

Berkey Member (of Mitchell)

27c. Limestone, very argillaceous, blue-gray, dolomitized. As much as 3 in (7.6 cm) of uppermost part belonging probably to Ten Mile Creek Dolomite, containing mixture of Silica species (*Pholidostrophia* and others) and Ten Mile Creek species (*Atrypa* and rugose corals) as well as marcasite concretions. 7-11 in (17.8-27.9 cm)

27b. Limestone, very argillaceous in lower part, less so near top, blue-gray, some small marcasite concretions. Mas-

sive bryozoa and *Strophodonta*. 6-8 in (15.2-20.3 cm)

27a. Limestone, argillaceous, massive, dark-blue gray, some small marcasite concretions, massive bryozoa and *Strophodonta*. 14-16 in (35.5-40.6 cm)

26. Limestone, very argillaceous, dark blue-gray, some small marcasite concretions. Abundant *Pholidostrophia* and *Strophodonta*. 3 in (7.6 cm)

25. Limestone, massive, argillaceous, dark blue-gray. Massive bryozoa and *Strophodonta;* basal 6 in (15.2 cm) with abundant *Streblotrypa*. 10-11 in (25.4-27.9 cm)

24B. Limestone, extremely argillaceous, weathering into angular fragments, gray. Fossils rare except for abundant *Mucrospirifer* at base. 6 in (15.2 cm)

24A. Limestone, very argillaceous, gray, containing scattered marcasite. Abundant massive bryozoa and *Mucrospirifer;* pyritized concentrations of *Streblotrypa* at top and base. 4 in (10.2 cm)

23. Limestone, massive, argillaceous, dark-gray but lighter than underlying unit, many marcasite concretions; grading into units below and above but harder than either. *Leiorhynchus kelloggi* abundant, *Mucrospirifer* common. 8 in (20.3 cm)

22. Limestone, massive, argillaceous, dark-gray, some marcasite concretions. *Devonochonetes, Leiorhynchus kelloggi, Mucrospirifer,* and massive bryozoa characteristic. 4 in (10.2 cm)

21. Limestone, massive, slightly argillaceous, dark-gray, many marcasite concretions, harder than units below and above. Numerous *Aulocystis, Mucrospirifer, Strophodonta,* and massive bryozoa present. 5 in (12.7 cm)

20. Limestone, argillaceous, dark-gray. *Strophodonta* and massive bryozoa; few auloporoids (South Quarry only). 3 in (7.6 cm)

19. Limestone, massive, slightly argillaceous, hard. Base containing phosphate nodules and comminuted fish bones; basal surface preserving casts of trails from uppermost surface of underlying unit. Abundant *Leiorhynchus kelloggi, Mucrospirifer,* and *Strophodonta;* some massive bryozoa. 7 in (17.8 cm)

Disconformity

18B. Shale, calcareous, dark-gray, carbonaceous, strong petroliferous odor on fresh surface; weathering into light-gray angular fragments; some pyrite noted on weathered surfaces. Fossils scarce except where *Aulocystis* bioherm is developed in North Quarry in unit 18A. 21 ft (640 cm)

18A. Shale, calcareous, gray to dark-gray, similar to unit 18B. One or more argillaceous limestone lenses may be present near base. Abundant *Aulocystis, Mucrospirifer,* and *"Sphenophragmus;"* an *Aulocystis* thicket or bioherm well developed in north end of North Quarry, where *Camarotoechia* and numerous pelecypods also occur in both 18A and 18B. 9 in-10 ft 3 in (22.8-312 cm)

17. Limestone, massive and argillaceous at base, becoming very argillaceous at top, dark-gray. Very abundant *"Ambocoelia umbonata;" Leiorhynchus, Mucrospirifer,* and *Rhipidomella* fairly common. 11 in (27.9 cm)

16. Limestone, massive, slightly argillaceous, gray, weathering olive-gray, grading into overlying unit but sharply separated from underlying shale; concentrically banded marcasite concretions. Abundant *Devonochonetes, Mucrospirifer,* and massive bryozoa; fauna concentrated near base. 6-12 in (15.2-30.5 cm)

Disconformity (?)

15. Shale, calcareous, gray. Abundant *Devonochonetes* and *Mucrospirifer*. 5-7 in (12.7-17.8 cm)

14B. Limestone, very argillaceous, dark-gray. Very abundant *Rhipidomella* and *Strophodonta*. 3 in (7.6 cm)

14A. Limestone, massive, argillaceous, light- to dark-gray. Massive bryozoa, *Protoleptostrophia,* and *Strophodonta* common. Base of unit preserving casts of trails and burrows from uppermost surface of underlying unit. 1 ft 9 in-2 ft 2 in (53.3-66.0 cm)

Disconformity

Brint Road Member (of Mitchell)

13. Shale, calcareous, dark-gray. Where unit 12 is developed as a limestone lens (as in part of South Quarry), shale contains many crinoids and blastoids, including *Arthroacantha carpenteri, Gilbertsocrinus ohioensis,* and *Euryocrinus laddii; Streblotrypa anomala, Sulcoretepora deissi,* and other cryptostomatous bryozoa very abundant. At other places, where unit 12 is represented by shale, top of unit contains comminuted echinoderm columnals and concentrations of bryozoa. 0.25-1.25 in (0.63-3.2 cm)

12. Limestone, argillaceous, light-gray, usually consisting of several lenses (North Quarry); in many parts of South Quarry absent or represented by shale. *Streblotrypa anomala, Sulcoretepora deissi,* and other cryptostomatous bryozoa very abundant (North Quarry and limestone lens in South Quarry). 3-12 in (7.6-30.5 cm)

11. Shale, calcareous, gray, many marcasite concretions, weathering into angular fragments. *Devonochonetes* and *Styliolina fissurella* abundant; some ostracods; few *Paraspirifer* valves and fragments of *Rhinocaris*. 1 ft 7 in-2 ft 2 in (48.3-65.9 cm)

10. Limestone, argillaceous, gray, in North Quarry consisting of 1 to 3 lenses. Abundant bryozoa, including *Acanthoclema ohioense, Streblotrypa anomala, Helopora inexpectata,* and *Sulcoretepora deissi*. 4-6 in (10.2-15.2 cm)

9B. Shale, calcareous, blue-gray, abundant marcasite concretions. *Devonochonetes, Mediospirifer audaculus, Phacops rana milleri,* and *Rhinocaris ehlersi* characteristic. 6 ft 10 in (208.3 cm)

9A. Limestone, argillaceous at base to very argillaceous at top, blue-gray, abundant marcasite concretions, weathering to sticky clay when wet. Very fossiliferous, producing most of the common Silica species; *Mucrospirifer prolificus, Phacops rana milleri,* and *Paraspirifer bownockeri* common. 8 in (20.3 cm)

8A. Limestone, massive argillaceous, blue-gray, abundant marcasite concretions, relatively hard. All fossils strongly pyritized. *Mucrospirifer prolificus* and *Strophodonta* abundant. 8-12 in (20.3-30.5 cm)

7C. Shale, calcareous, blue-gray. Many fossils worn by wave action before burial. Best developed in north end of North Quarry. *Megastrophia* and *Strophodonta* abundant. 2-3 in (5.1-7.6 cm)

7B. Shale, calcareous, blue-gray. *Devonochonetes* and *Mucrospirifer prolificus* abundant. 10 in (25.4 cm)

7A. Shale, calcareous, blue-gray, with occasional argillaceous limestone lens. Contains much water-worn fossil debris. Large *Atrypa* abundant in lower 1 ft; *Devonochonetes, Fistulipora vesiculata, Megastrophia, Mucrospirifer prolificus, Pholidostrophia, Protoleptostrophia, Strophodonta,* and many other species abundant; *Cystiphylloides americanum, Heliophyllum halli,* and *Heterophrentis simplex* found at base. *Hercostrophia robusta* and *Pleurodictyum* (*Procteria*) *cornu* restricted to this unit. 18 in (45.7 cm)

Disconformity

"Blue limestone" of older reports

6. Limestone, argillaceous, blue-

gray, very argillaceous at top and base. *Atrypa* and *Strophodonta* abundant; *"Spinocyrtia euryteines"* abundant at top of unit; *Athyris, Lophonychia cordata, Mucrospirifer, Schizophoria ferronensis,* and tetracorals less common; *Platyceras* and trepostomatous bryozoa present. 1 ft (30.5 cm)

5B. Limestone, massive, argillaceous, blue-gray, crystalline. *"Spinocyrtia euryteines," Strophodonta,* and massive bryozoa common. 1 ft 3 in (35.1 cm)

5A. Limestone, massive, slightly argillaceous, blue-gray; composed of bands of brachiopod debris. *Cyrtina, Heterophrentis,* and other tetracorals abundant. 2 ft 9 in (83.7 cm)

4. Limestone, very argillaceous, blue-gray, weathering to clay. Fossils rare. 2-4 in (5.0-10.2 cm)

3. Limestone, massive, bioclastic, blue-gray weathering to brown. *Atrypa, Cyrtina, Hexagonaria anna, Hexagonaria tabulata,* and *Strophodonta* abundant; numerous simple rugose corals, tabulate corals, and spiriferid brachiopods. 12-14 in (30.5-38.1 cm)

2. Limestone, massive, bioclastic, blue-gray weathering to brownish-gray. Abundant *Devonochonetes coronatus* near base; *Favosites* and *Hexagonaria* common. 10-14 in (25.4-38.1 cm)

1. Limestone, massive, bioclastic, blue-gray. Abundant *Atrypa, Devonochonetes coronatus, Megastrophia, Protoleptostrophia, Strophodonta,* and *Tropidoleptus carinatus; Paracyclas* and *Gosselettia triquetra* present. 1 ft 4 in (40.6 cm)

Disconformity

Dundee Limestone (top of unit)

Limestone, light bluish-gray in beds 4-12 in (10.2-30.5 cm) thick, highly fossiliferous. Most characteristic fossil of unit *Productella spinuicosta; Cyrtina* abundant in lower and upper parts; *Brevispirifer lucasensis,* an excellent guide fossil, present; *Atrypa costata,* other brachiopods, *Hexagonaria, Favosites,* and bryozoa present. (152 cm)

ACKNOWLEDGEMENTS. We thank the administration of the France Stone Company for granting us permission to enter their property and for assistance in planning this field excursion. Appreciation is also extended to William A. Kneller of the Department of Geology, University of Toledo, for his help in the preliminary planning.

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